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### **Scientific Organising Committee**

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Sushil Atreya (The University of Michigan)

Vincent Chevrier (University of Arkansas)

Agustin Chicarro (ESA/ESTEC, Noordwijk)

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Olivier Witasse (ESA/ESTEC, Noordwijk)

Richard W. Zurek (NASA Jet Propulsion Laboratory)

#### **Some Numbers**

- Almost 100 participants (66% Europe, 20% US, and the rest from other places);
- 3 days;
- 13 hours of talks;
- 4.5 hours of discussion;
- 1.5 hours for posters;
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- 2 social events: welcome drink and dinner.

#### Joint ESA-ASI Methane Workshop, 27–27 November 2009, Frascati (I)





Lively discussions





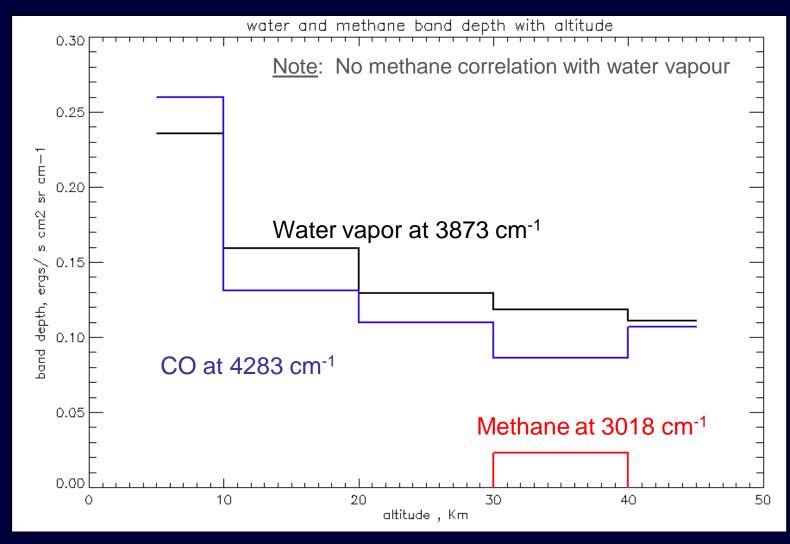
#### **Sessions**

- 1. Observations of methane from Mars orbit;
- 2. Earth-based observations of Martian methane;
- 3. Martian surface and subsurface data, and laboratory measurements relevant to the study of methane;
- 4. Origin of methane;
- 5. Storage, release, and delivery of methane;
- 6. Atmospheric circulation and chemistry;
- 7. Microbial life, metabolism in water ice, and biological experiments under Martian conditions;
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# Some highlights

### Mars Express Observations

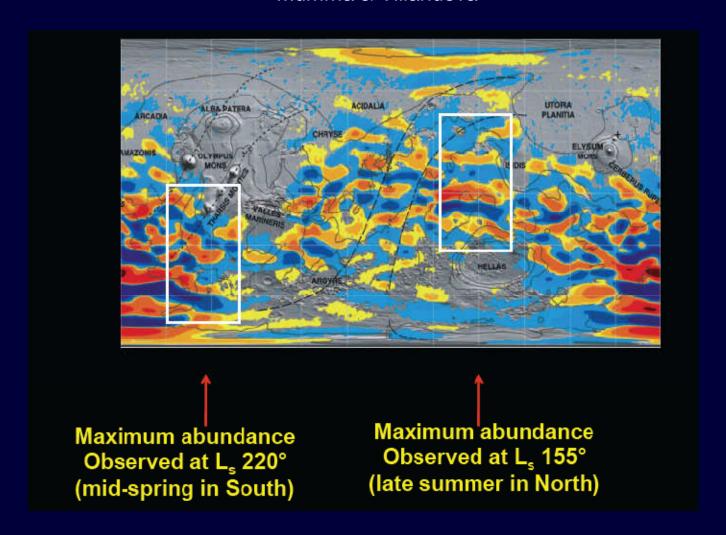
Vertical profile of H<sub>2</sub>O, CO, and CH<sub>4</sub> during Spring



Message: Methane is not found close to the surface.

### **Earth-based Observations**

Mumma & Villanueva



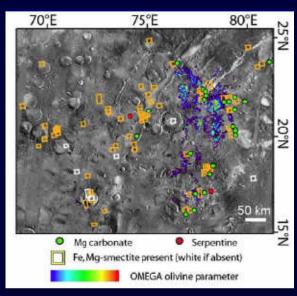
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### **Summary of the observations**

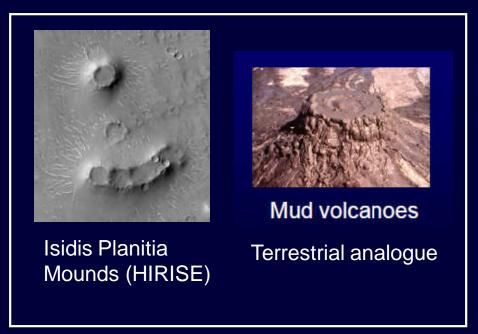
- Mars Express/PFS :
  - New CH₄ vertical profiles;
  - New maps, characterized by large contrasts on regional scales;
  - Maximum abundances of methane occur near the north pole in mid to late summer;
- Earth-based observations:
  - Confirmation of previous findings;
  - CH<sub>4</sub> is found over old terrains;
- MGS/TES observations of methane were also reported, showing an enhancement in methane over Tharsis and Arabia Terra;
- Further work is required to reconcile the spacecraft and ground-based observations.

### **Geological and Geochemical Context**

Methane-rich regions seem to have landforms/mineralogy with possible implications for past methane-related geological processes. Correlating methane to regional geology is a potentially powerful tool that we are just beginning to explore.



Nillie Fossae (Ehlmann et al 2009)



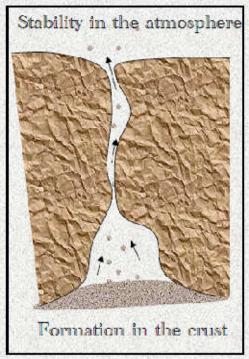
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- The presence of methane on Mars remains puzzling;
- Origin: biological or geochemical (or both);
- All other potential production mechanisms —exogenic (comets, meteorites), volcanic, and atmospheric— have been ruled out;
- If the production of methane is ongoing, it points to the presence of underground aquifers;
- If the methane was produced when Mars was supposedly warmer and liquid water flowed on the surface, it could have been stored (as clathrates) and is possibly being released from time to time.

## Storage

#### Release of methane clathrate particles

- Formation of clathrate in the crust at high (lithostatic) pressure.
- 2- Fracturation of subsurface by tectonics, yielding local macroporosity
- 3- Erosion of (friable) clathrate host framework and uplift of particles.
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New hypothesis (E. Chassefière): Methane release could come from clathrates in the atmosphere. This could explain the (not well established correlation with  $H_2O$ ).

### **Atmospheric Circulation**

Lefèvre & Forget

#### **Conclusions**

- The "conventional" atmospheric chemistry does not produce measurable methane variations on Mars, even in the case of a current, episodic, and localized source.
- The condensation/sublimation cycle of CO<sub>2</sub> should generate large-scale methane variations at high latitudes (but they differ from what is observed).
- CSHELL/NIRSPEC: In the most favourable case, an atmospheric CH<sub>4</sub> lifetime of less than 200 days (seasonal release) or ~2 Earth years (single event) is necessary to reproduce the observations.
- PFS: measurements at high latitudes require a lifetime of less than ~3 Earth years. Longitudinal variations at high latitudes and seasonal trends at mid-to-low latitudes cannot be reproduced.
- The CH<sub>4</sub> source: quantitative agreement with the observations requires considerable amounts:

~150 000 tonnes

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Mid-Atlantic Ridge: 50 000-130 000 t yr (Keir et al., 2005)

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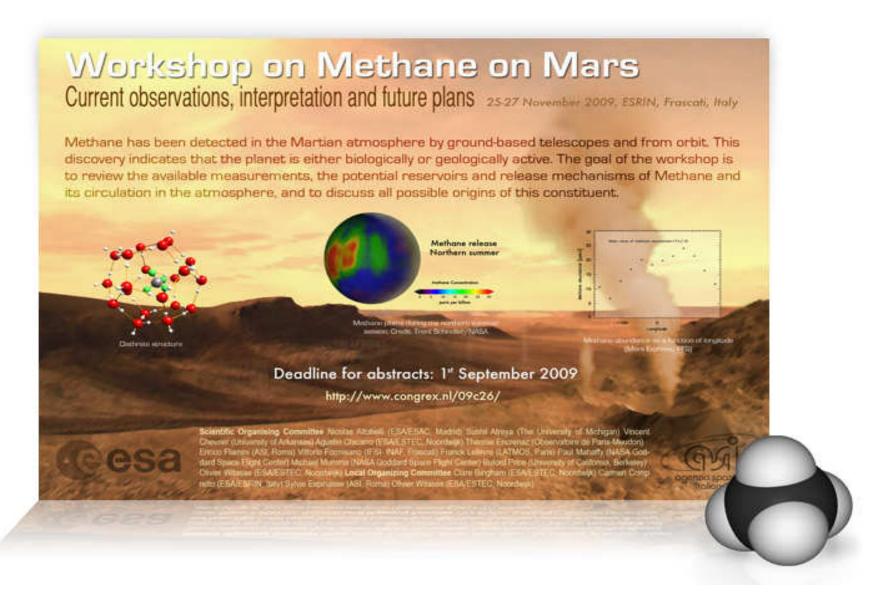
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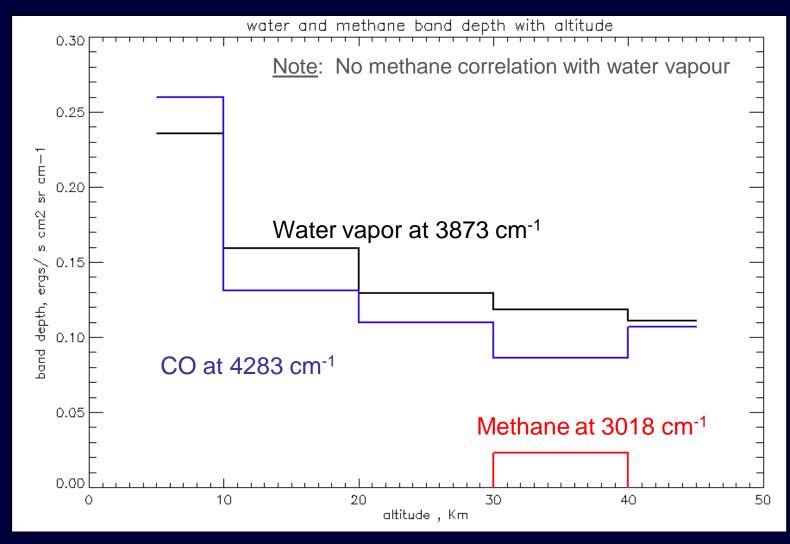
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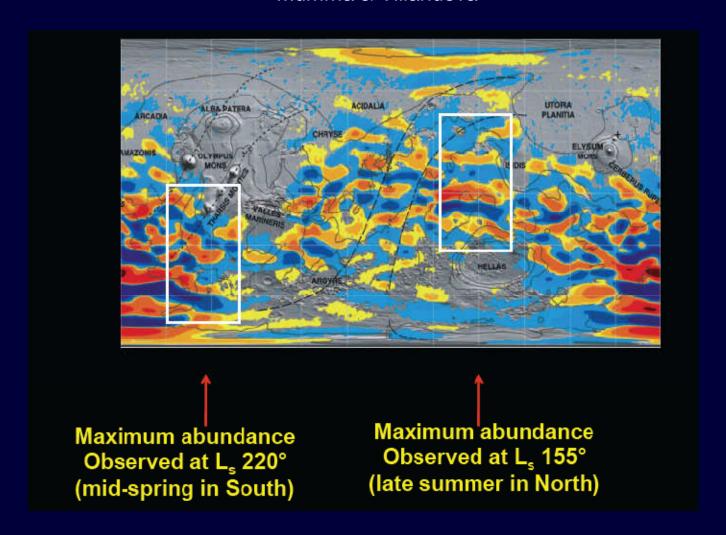
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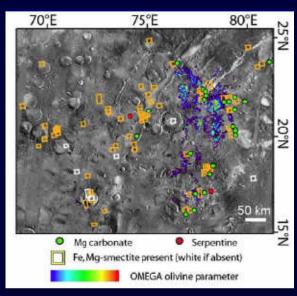
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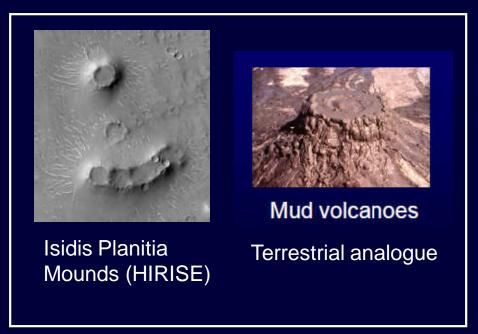
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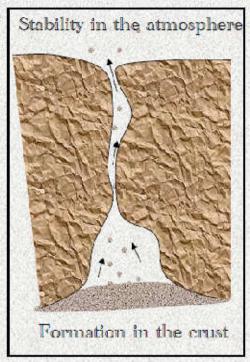
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